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Title: Structural strain monitoring of a composite scaled turbine blade using embedded QRS sensoring

Key words: SHM, embedded sensor, Composite instrumentation, composite health monitoring, QRS sensor, composite blade monitoring

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Abstract :

The growing development of renewable energies is leading to the fabrication of composite parts that will be subjected to more severe environment, such as the case of tidal and offshore wind turbine blades. The maintenance cost of these composite parts is into their operational costs (OPEX) and impacts directly the energy cost generated by them. The condition based monitoring and structural health monitoring are compulsory to reduce the OPEX and make these renewable energies more attractive.

One of the difficulties of monitoring such structures is for instance their operation in harsh environment, therefore impacting the reliability of the sensing and measurement system. This paper addresses the utilization of embedded Quantum Resistive Sensors (QRS) for strain measurements in composite structures during operation. Such kind of sensor is twofold interesting, since it can be embedded in the structure, it is **not exposed to harsh environment** and also it can **measure strains inside the composite structure**.

The QRS is made with the addition of carbon nanotubes in an epoxy resin and can be embedded in the core of the structure during its fabrication; this embedment process is also addressed here. Thanks to their very low thickness (less than 10μm), QRS are less intrusive when embedded and avoids degradation of structure's mechanical properties, and creation of new defects (1).

This R&D project was developed under the French project called EVEREST (3), where a scaled tidal turbine blade was manufactured in carbon composite with QRS embedded sensors and mechanically tested for structural monitoring (2, 3). The results are encouraging and showed that a resistance drifting of the QRS happens during structural loading, which is related to damage initiation in the composite structure. This behavior can be exploited as "smart material" and is correlated to the damage level of the sensor itself and the composite structure, and therefore employable in SHM. The measurement results and application of QRS is assessed experimentally and discussed in this article.

References:

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